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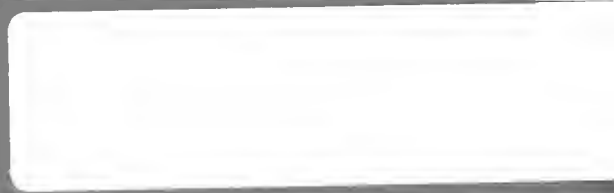
**FACULTY WORKING
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**Discordant Beliefs and Trading Activity In the Stock
Options Market: Some Preliminary Empirical Evidence**

*William T. Moore
David A. Ziebart*

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**FACULTY WORKING
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The Information Content of Annual Accounting Data: An Empirical Modeling Approach Using Structural Equation Techniques

David A. Ziebart

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The Information Content of Annual Accounting Data:
An Empirical Modeling Approach Using
Structural Equation Techniques

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Department of Accountancy

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Abstract

The intent of this study is to re-examine the information content of annual accounting data using a more sophisticated approach in which a measurement model linking accounting variables to four underlying financial dimensions and then a structural model linking the dimensions to abnormal returns is estimated and tested. Accordingly, this study has two major research thrusts. A measurement model is employed to combine various financial accounting information into four fundamental firm dimensions. The second thrust is that an overall hypothesized model structure is estimated and tested. Variations in the price reactions are decomposed into the components attributable to the unexpected changes in liquidity, leverage, profitability, and activity financial dimensions.

1.0 Purpose of the Study

The accounting literature abounds with studies which investigate the reactions of the financial market to the issuance of corporate financial data. For the most part, these studies focus on the market reactions to earnings data. Few researchers have tried to investigate the market reactions to both earnings and financial position data. Gonedes (1974) undertakes to study the association of seven accounting ratios with associated stock market price reactions. His results indicate that the abnormal returns accompanying the release of the annual accounting data are driven predominantly by earnings information.

The intent of this study is to re-examine the topic using a more sophisticated approach in which a model linking accounting ratios to four underlying financial dimensions and then linking the dimensions to the abnormal returns is estimated and tested. Accordingly, this study has two major research thrusts. The first research thrust is that a measurement model is employed to combine various financial accounting information into four fundamental firm dimensions. Instead of trying to link the market reactions to various financial ratios, the reactions are linked to four underlying financial dimensions of the firm; liquidity, leverage, profitability, and activity. Each of these dimensions is measured by a group of financial ratios and the covariance structure among the ratios is used to formulate the magnitudes of the unobservable financial dimensions. The second thrust of this study is that it goes beyond simple statistical analysis of covariation and develops a hypothesized model structure. The

variations in the price reactions of the market are decomposed into the components attributable to the variation in the unexpected changes in the liquidity, leverage, profitability, and activity financial dimensions. The significance of the hypothesized links between the market reactions and the financial dimensions is tested. This allows assessment of the information content for each of the four financial dimensions. Additionally, through over-identification of the hypothesized model structure, the model configuration itself is tested.

The hypothesized structural model configuration linking abnormal returns to the financial dimensions and the measurement model configuration linking the underlying financial dimensions to the financial ratios are presented in the next section. The third section summarizes the parameter estimation and model testing techniques. The analysis and results are presented in section four while the final section provides the conclusions and implications of the results.

2.0 Hypothesized Model

The overall model developed and tested in this paper is made up of two components. The measurement model links the accounting data to four underlying financial dimensions and the structural model links the financial dimensions to the market reactions.

Ohlson (1979) provides an analytic model relating accounting information to security valuation. His study examines security valuation relative to the stochastic behavior of accounting numbers. The model developed is the following:

$$P_t = A + \sum_{i=1}^N B_i X_{it} + CD_t$$

where: P_t is the price of the security at time t .

$\underline{X}_t = (X_{1t}, X_{2t}, \dots, X_{nt}, D_t)$ is a vector of datum concerning the economic attributes of the firm at time t .

X_{it} denotes financial accounting numbers that represent the economic attributes of the firm at time t .

D_t is dividends paid at time t .

$A, B_1, B_2, \dots, B_n, C$ are the valuation parameters obtained by solving a system of simultaneous equations.

Ohlson does not stipulate the accounting numbers to be used in the model but asserts (p. 318), "the fundamental characteristics of financial variables are their (joint) stochastic time-series behavior . . . information variables in this mode of analysis can be any type of variable that affects investors' expectations about future events."

In this study, the four variables assumed to affect investors' expectations about future events are the four financial dimensions of the firm; liquidity, leverage, profitability, and activity. The choice of these dimensions reflects the types of annual accounting data studied by Gonedes (1974). In addition, these four dimensions are found extensively in discussions of "financial statement analysis." (For example, see Lev (1974), Foster (1978), or Van Horne (1980).)

The number of data items inherent in an annual financial report is very large. In many cases, these items are highly interrelated and purport to measure the same economic attributes of the firm. The approach of this study, adapted from Ohlson (1979, p. 317), "stipulates

the existence of 'real' economic variables and then uses accounting data as estimates of the real variables."

Each of the four financial dimensions is an unobservable construct representing the financial and operating aspects of a firm. Annual accounting data provides measures of these dimensions. Each of the financial dimensions has multiple ratios which are considered to be measures of the underlying dimension. The four financial dimensions and their measures (ratios) used in this study are:

Liquidity

- current ratio
- quick ratio
- defensive ratio

Leverage

- total debt to equity ratio
- long-term debt to equity ratio
- times interest earned

Profitability

- return on assets
- earnings to sales ratio
- primary earnings per share
- return on common stockholders' equity

Activity

- asset turnover
- receivable turnover
- inventory turnover

These ratios and the financial dimensions they measure constitute the components of the measurement model.

Mock (1976) suggested the use of accounting information as observable measures of unobservable constructs. The basic model of this approach depicts the observable measure (accounting data or ratio) as a function of the underlying financial dimension and a measurement error term. Let x represent the measure (financial ratio), ξ

represent the underlying dimension, and δ represent the measurement error. The measurement model for each ratio can be depicted as:

$$X_t = \xi_t + \delta_t$$

Since this paper is investigating the impact of accounting information on the market, the actual variables studied are the unexpected changes in the accounting ratios and the unexpected changes in the underlying financial dimensions which result from the issuance of the financial statements.

The components of the measurement model are defined as follows:

- ξ_1 = expectation error regarding the liquidity dimension
- ξ_2 = expectation error regarding the leverage dimension
- ξ_3 = expectation error regarding the profitability dimension
- ξ_4 = expectation error regarding the activity dimension
- x_1 = expectation error of the current ratio
- x_2 = expectation error of the quick ratio
- x_3 = expectation error of the defensive interval
- x_4 = expectation error of the long term debt to equity ratio
- x_5 = expectation error of the total debt to equity ratio
- x_6 = expectation error of the times interest earned ratio
- x_7 = expectation error of the return on total assets
- x_8 = expectation error of the earnings to sales ratio
- x_9 = expectation error or primary earnings per share
- x_{10} = expectation error of the return on equity
- x_{11} = expectation error of the total asset turnover
- x_{12} = expectation error of the accounts receivable turnover

x_{13} = expectation error of the turnover ratio

λ = measurement coefficient between the observable measure and the underlying/unobservable financial dimension expectation error

δ_1 to δ_{13} = the associated measurement error

The overall measurement model relating the four financial dimensions to the observable accounting ratios is comprised of thirteen equations. Each equation represents a single accounting ratio as a measure of a single underlying financial dimension. The liquidity, leverage, and activity dimensions each have three ratios as measures of the underlying dimension. The profitability dimension is measured by four ratios. Each of the thirteen ratios is an imperfect measure of the appropriate underlying financial dimension and, therefore, each measurement model equation contains an error term. The thirteen equations comprising the hypothesized measurement model of this study are:

$$\begin{array}{ll} x_1 = \lambda_{11} \xi_1 + \delta_1 & x_8 = \lambda_{32} \xi_3 + \delta_8 \\ x_2 = \lambda_{12} \xi_1 + \delta_2 & x_9 = \lambda_{33} \xi_3 + \delta_9 \\ x_3 = \lambda_{13} \xi_1 + \delta_3 & x_{10} = \lambda_{34} \xi_3 + \delta_{10} \\ x_4 = \lambda_{21} \xi_2 + \delta_4 & x_{11} = \lambda_{41} \xi_4 + \delta_{11} \\ x_5 = \lambda_{22} \xi_2 + \delta_5 & x_{12} = \lambda_{42} \xi_4 + \delta_{12} \\ x_6 = \lambda_{23} \xi_2 + \delta_6 & x_{13} = \lambda_{43} \xi_4 + \delta_{13} \\ x_7 = \lambda_{31} \xi_3 + \delta_7 & \end{array}$$

Figure 1 is a diagram of the hypothesized measurement model. Recall that the x 's represent the observed expectation errors (unexpected changes) of the various accounting ratios and the ξ 's

represent the expectation errors (unexpected changes) in the underlying financial dimensions. The δ 's represent the measurement errors since each ratio is an imperfect measure of the underlying dimension. Since the financial dimensions are interrelated they are modeled as covarying and they are not constrained to be orthogonal.

INSERT FIGURE 1

The hypothesized structural model links the unexpected changes in the financial dimensions to the market reaction measured by the abnormal returns. The structural model, in equation form, is

$$\eta_1 = \gamma_{11} \xi_1 + \gamma_{12} \xi_2 + \gamma_{13} \xi_3 + \gamma_{14} \xi_4 + \zeta_1$$

where: η_1 = market's price reaction as measured by the cumulative abnormal return (CAR)

ξ_1 = expectation error regarding the liquidity dimension

ξ_2 = expectation error regarding the leverage dimension

ξ_3 = expectation error regarding the profitability dimension

ξ_4 = expectation error regarding the activity dimension

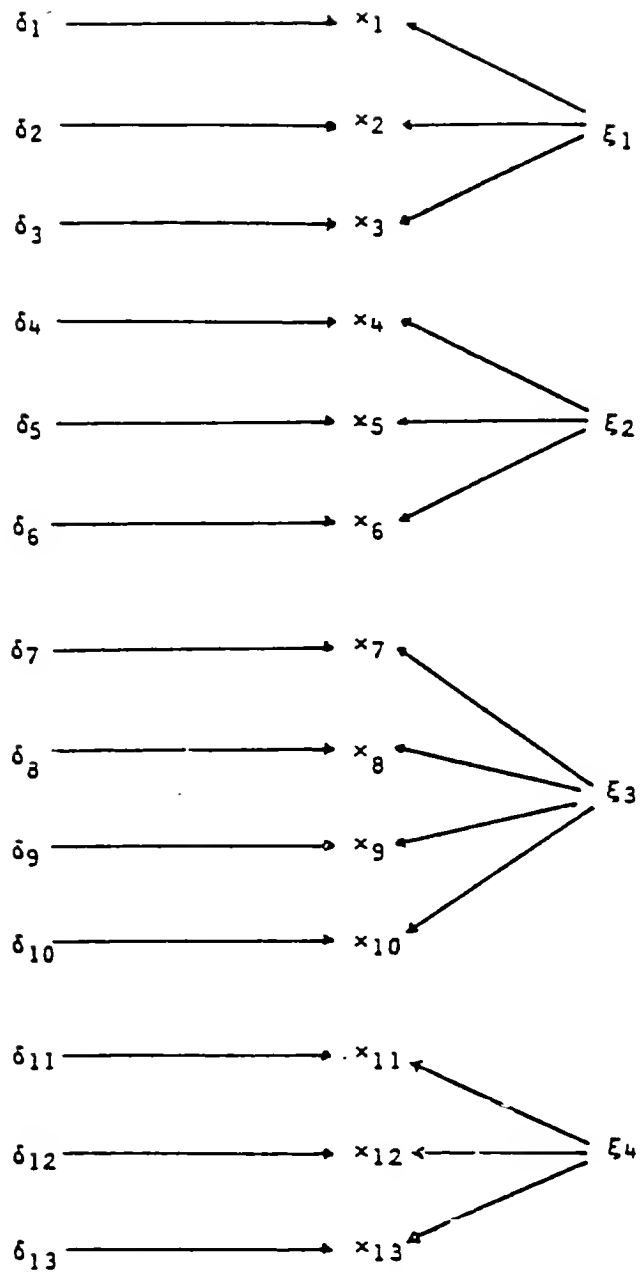
γ = causal path coefficient between expectation error regarding the financial position dimension and the market reaction

ζ_1 = prediction error of price reaction

Figure 2 is a diagram of the hypothesized structural model.

INSERT FIGURE 2

The total model hypothesized in this study is a combination of the measurement model and the related structural model. A diagram of the



where it is assumed that the ξ 's are not orthogonal and may covary.

Figure 1. Hypothesized Measurement Model

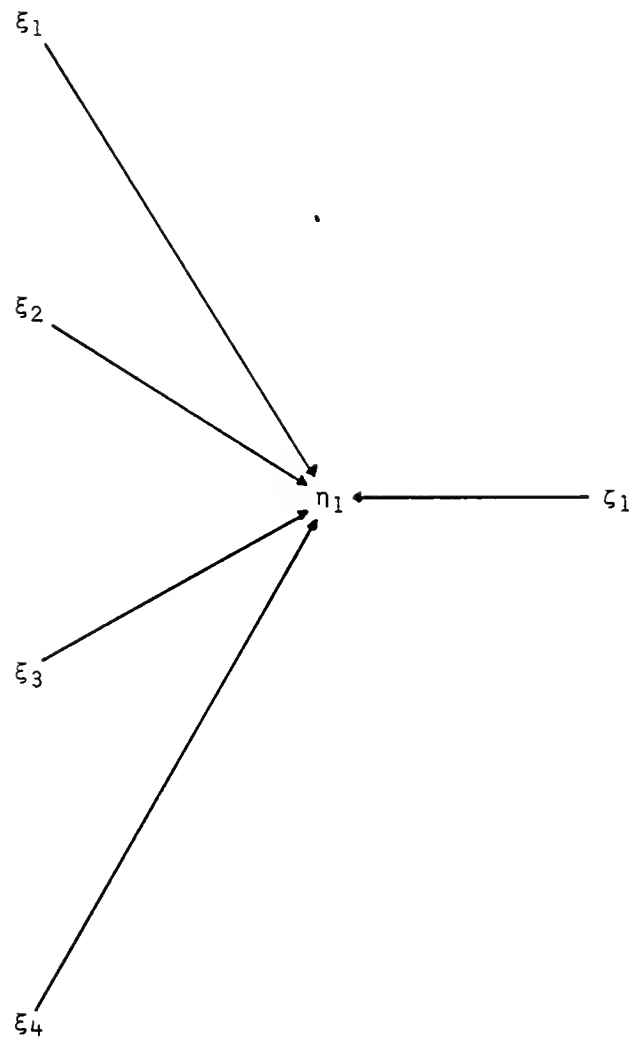


Figure 2. Hypothesized Structural Model

total model (measurement model and structural model) is presented in Figure 3.

INSERT FIGURE 3

The total model configuration can be summarized as follows:

$$\eta_1 = \gamma_{11} \xi_1 + \gamma_{12} \xi_2 + \gamma_{13} \xi_3 + \gamma_{14} \xi_4 + \gamma_1$$

$$x_1 = \lambda_{11} \xi_1 + \delta_1$$

$$x_8 = \lambda_{32} \xi_3 + \delta_8$$

$$x_2 = \lambda_{12} \xi_1 + \delta_2$$

$$x_9 = \lambda_{33} \xi_3 + \delta_9$$

$$x_3 = \lambda_{13} \xi_1 + \delta_3$$

$$x_{10} = \lambda_{34} \xi_3 + \delta_{10}$$

$$x_4 = \lambda_{21} \xi_2 + \delta_4$$

$$x_{11} = \lambda_{41} \xi_4 + \delta_{11}$$

$$x_5 = \lambda_{22} \xi_2 + \delta_5$$

$$x_{12} = \lambda_{42} \xi_4 + \delta_{12}$$

$$x_6 = \lambda_{23} \xi_2 + \delta_6$$

$$x_{13} = \lambda_{43} \xi_4 + \delta_{13}$$

$$x_7 = \lambda_{31} \xi_3 + \delta_7$$

In summary, this model hypothesizes that abnormal returns are linked to unexpected changes in four financial dimensions which result from the issuance of annual accounting statements. Each of the unexpected changes in the financial dimensions is portrayed as being measured by unexpected changes in a group of financial ratios.

3.0 Statistical Techniques

The estimation of all of the parameters is accomplished simultaneously so that the total structure is considered. However, to explain what is occurring, the estimation of the measurement model and the structural model will be described individually.

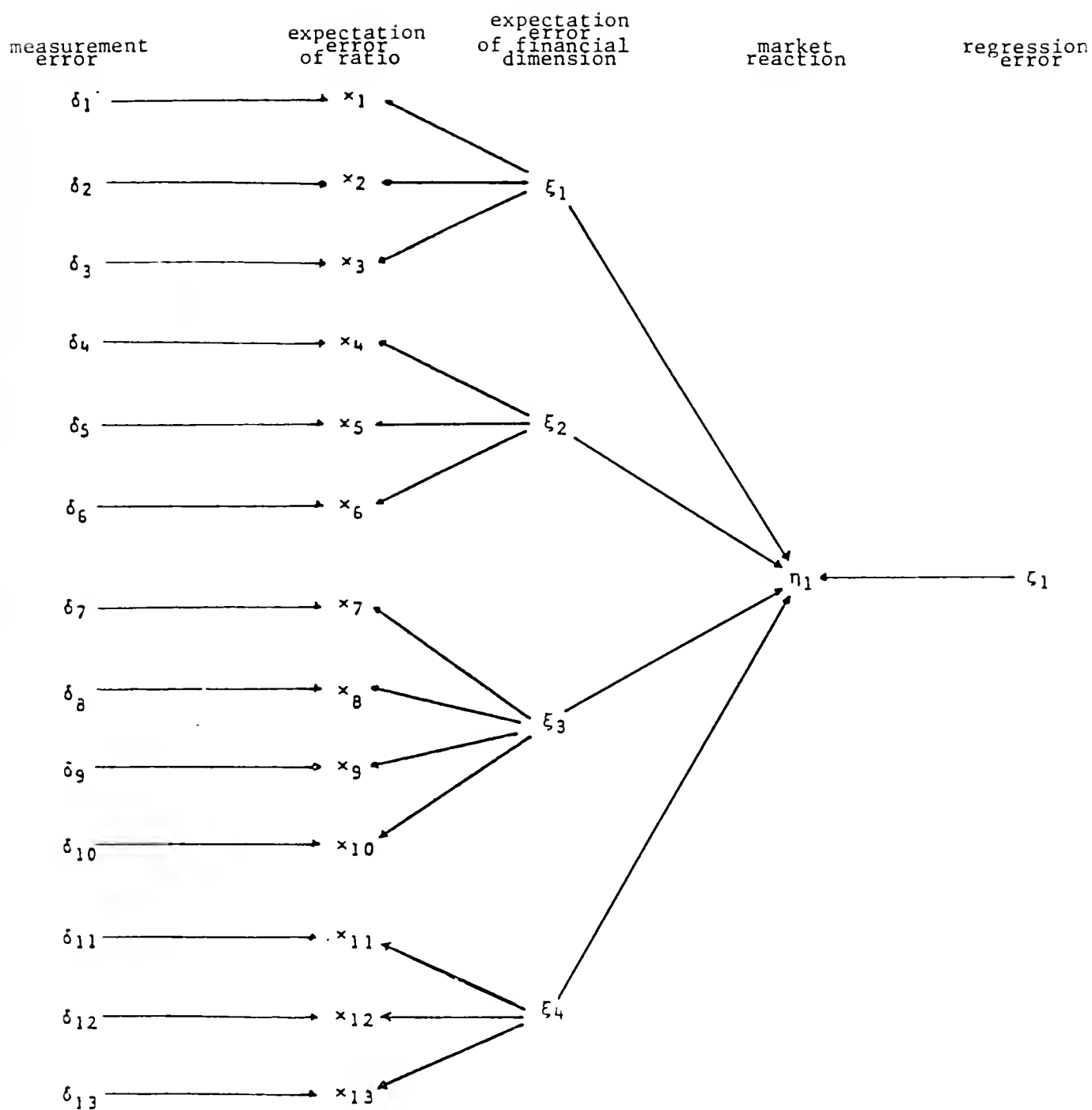


Figure 3. Total Model Configuration

The measurement model is a factor analytic approach to the estimation of a set of underlying dimensions from the accounting ratios. The unexpected changes in the financial dimensions are estimated from the observed unexpected changes in the financial ratios which result from the issuance of the financial statements. A confirmatory factor analysis is conducted on the unexpected changes in the financial ratios with the loadings of the variables constrained to certain dimensions. The expectation errors regarding the current ratio, quick ratio, and defensive interval are constrained to load on the liquidity dimension and are not allowed to load on any of the other three dimensions. Likewise, the accounting ratios hypothesized to be measures of other dimensions are constrained to load only on the dimension they are to measure. Using information regarding the theoretical measurement structure, the factor analysis is constrained to the hypothesized model configuration and the factor analysis is an oblique solution since the underlying dimensions are allowed to covary.

The structural model of the hypothesized configuration is a single equation regression. The model regresses abnormal returns on the unexpected changes in the four financial dimensions. In effect, the abnormal returns are regressed on the factor analytic derived dimensions of the measurement model.

The estimation of the model is accomplished using a FIML, Full Information Maximum Likelihood, approach. The estimation package chosen is LISREL: Analysis of Linear Structural Relationships by the Method of Maximum Likelihood by Joreskog and Sorbom (1978). Appendix

A contains a glossary and a description of the notation used in LISREL and adopted in this paper.

The hypothesized model of this project,

$$\begin{aligned} \eta_1 &= \gamma_{11} \xi_1 + \gamma_{12} \xi_2 + \gamma_{13} \xi_3 + \gamma_{14} \xi_4 + \gamma_1 \\ x_1 &= \lambda_{11} \xi_1 + \delta_1 & x_8 &= \lambda_{32} \xi_3 + \delta_8 \\ x_2 &= \lambda_{12} \xi_1 + \delta_2 & x_9 &= \lambda_{33} \xi_3 + \delta_9 \\ x_3 &= \lambda_{13} \xi_1 + \delta_3 & x_{10} &= \lambda_{34} \xi_3 + \delta_{10} \\ x_4 &= \lambda_{21} \xi_2 + \delta_4 & x_{11} &= \lambda_{41} \xi_4 + \delta_{11} \\ x_5 &= \lambda_{22} \xi_2 + \delta_5 & x_{12} &= \lambda_{42} \xi_4 + \delta_{12} \\ x_6 &= \lambda_{23} \xi_2 + \delta_6 & x_{13} &= \lambda_{43} \xi_4 + \delta_{13} \\ x_7 &= \lambda_{31} \xi_3 + \delta_7 \end{aligned}$$

is a specified form of the following general model (Joreskog and Sorbom, 1978, pp. 4-7)

$$\underline{\beta} \underline{\eta} = \underline{\Gamma} \underline{\xi} + \underline{\zeta} \quad (1)$$

where: $\underline{\eta}$ (mx1) is a vector of the latent (underlying/unobservable) endogenous variables

$\underline{\xi}$ (nx1) is a vector of the latent (underlying/unobservable) exogenous variables

$\underline{\beta}$ (mxm) is the matrix of causal coefficients relating the endogenous variables to each other

$\underline{\Gamma}$ (mxn) is the matrix of causal coefficients relating the endogenous variables to the exogenous variables

$\underline{\zeta}$ (mx1) is a vector of random residuals or prediction errors.

$$\underline{Y} = \underline{\Lambda}_y \underline{\eta} + \underline{\varepsilon} \quad (2)$$

$$\underline{X} = \underline{\Lambda}_x \underline{\xi} + \underline{\delta} \quad (3)$$

where: \underline{Y} (px1) are observations/indicators/measures of the latent endogenous variables $\underline{\eta}$

\underline{X} (qx1) are observations/indicators/measures of the latent exogenous variables $\underline{\xi}$

$\underline{\Lambda}_y$ (pxm) is a matrix of regression coefficients of \underline{Y} on $\underline{\eta}$

$\underline{\Lambda}_x$ (qxn) is a matrix of regression coefficients of \underline{X} on $\underline{\xi}$

$\underline{\epsilon}$ is a vector of measurement errors for \underline{Y} as measures of $\underline{\eta}$

$\underline{\delta}$ is a vector of measurement errors for \underline{X} as measures of $\underline{\xi}$.

Let: $\underline{\Phi}$ (n x n) = covariance matrix of the exogenous variables, $\underline{\xi}$

$\underline{\Psi}$ (m x m) = covariance matrix of the prediction errors, $\underline{\zeta}$

$\underline{\Theta}_{\epsilon}$ = covariance matrix of the measurement errors of the endogenous variables

$\underline{\Theta}_{\delta}$ = covariance matrix of the measurement errors of the exogenous variables.

The variance-covariance matrix of the x and y variables created by the specified model is (Joreskog and Sorbom, 1978, p. 5):

$$\underline{\Sigma} ((p + q) \times (p + q)) =$$

$$\begin{bmatrix} \underline{\Lambda}_y (\underline{\beta}^{-1} \underline{\Gamma} \underline{\Phi} \underline{\Gamma}' \underline{\beta}'^{-1} + \underline{\beta}^{-1} \underline{\Psi} \underline{\beta}'^{-1}) \underline{\Lambda}_y' + \underline{\Theta}_{\epsilon} & \underline{\Lambda}_y \underline{\beta}^{-1} \underline{\Gamma} \underline{\Phi} \underline{\Lambda}_x' \\ \underline{\Lambda}_x \underline{\Phi} \underline{\Gamma}' \underline{\beta}'^{-1} \underline{\Lambda}_y' & \underline{\Lambda}_x \underline{\Phi} \underline{\Lambda}_x' + \underline{\Theta}_{\delta} \end{bmatrix} \cdot (4)$$

The elements of the matrices, $\underline{\Lambda}_x$, $\underline{\Lambda}_y$, $\underline{\beta}$, $\underline{\Gamma}$, $\underline{\Phi}$, $\underline{\Psi}$, $\underline{\Theta}_{\epsilon}$, and $\underline{\Theta}_{\delta}$ are specified according to the hypothesized model to be free, constrained, or fixed.

The measurement model, equations (2) and (3), written in factor analytic form are:

$$\underline{Z} = \underline{\Lambda} \underline{f} + \underline{e}$$

$$\underline{Z} = (\underline{y}, \underline{x})$$

$$\underline{f} = (\underline{\eta}, \underline{\xi})$$

$$\underline{e} = (\underline{\varepsilon}, \underline{\delta})$$

$$\underline{\Lambda} = \begin{bmatrix} \underline{\Lambda}_y & \underline{0} \\ \underline{0} & \underline{\Lambda}_x \end{bmatrix}.$$

As such, the measurement model is a restricted factor analysis where the factors $\underline{\eta}$ and $\underline{\xi}$ satisfy a linear structural equation system of the following form:

$$\underline{\beta} \underline{\eta} = \underline{\Gamma} \underline{\xi} + \underline{\zeta}.$$

Through specification of $\underline{\Phi}$ (the covariance matrix of the exogenous variables) to be full rank, an oblique solution is obtained. For additional references on the use of factor analytic techniques in structural equation modeling see Jackson and Borgotta (1981, pp. 179-281), Judge, Griffiths, Hill and Lee (1980, pp. 550-554), or Hanushek and Jackson (1977, pp. 302-324).

For estimation and testing of the model it is assumed that the distribution of the observed variables can be described by the first two moments, a mean vector and a variance-covariance matrix. The estimation process comprises fitting the covariance matrix constructed by the hypothesized model specifications ($\underline{\Sigma}$) to the observed covariance matrix (\underline{S}).

$$\underline{S} \ (p + q) \times (p + q) = \begin{bmatrix} \underline{S}_{yy} \ (p \times p) & \underline{S}_{yx} \ (p \times q) \\ \underline{S}_{xy} \ (q \times p) & \underline{S}_{xx} \ (q \times p) \end{bmatrix}$$

The fitting function employed,

$$F = \log |\underline{\Sigma}| + \text{tr} (\underline{S} \underline{\Sigma}^{-1}) - \log |\underline{S}| - (p + q)$$

is minimized with respect to \underline{K} ; where \underline{K} is the set of free, constrained, or equivalent parameters designated by the hypothesized model structure. In minimizing the fitting function, one minimizes the difference between the generalized variance of the model created covariance matrix and the generalized variance of the observed covariance matrix. The estimation procedure selects estimates of the parameters that minimize the F function by taking the derivatives of the F function, with regard to each parameter estimated, and solving this set of simultaneous equations for the values that equate the derivatives to zero.

Once the maximum likelihood estimates of the parameters have been obtained the hypothesized model can be tested for goodness of fit since the hypothesized model structure is over-identified. The total hypothesized model configuration is tested to determine its ability to create a covariance matrix ($\underline{\Sigma}$) that replicates the covariance matrix (\underline{S}) of the observed variables. Let H_0 be the null hypothesis representing the total model as hypothesized. The alternative H_1 is that the created covariance matrix ($\underline{\Sigma}$) is any positive definite matrix. The test statistic NF_0 is minus twice the logarithm of the likelihood ratio (where F_0 is the minimum value of F and N is the sample size). NF_0 is asymptotically distributed as χ^2 with degrees of freedom d $\{d = 1/2 [(p + q) * (p + q + 1) - t]\}$ where t is the total number of independent parameters estimated under H_0 (Joreskog and Sorbom, 1978,

p. 14)}}. Appendix B contains a more complete discussion of the overall goodness of fit test.

4.0 Data Analysis

The firms studied are calendar year (non-financial or utilities) corporations listed on the New York Stock Exchange which announced annual earnings for 1979 during February 1980. The following criteria are used to pick an initial sample of 206 firms:

1. A firm must have complete requisite data on the CRSP monthly return data base for the period January 1, 1975 through March 1980.
2. A firm must have complete requisite trading volume data on the Rapidquote data base for the period January 1975 through March 1980.
3. A firm must have complete requisite accounting data on the Compustat yearly data base for 1978 and 1979.
4. A firm must have filed third quarter, 1978 and 1979 10-Q reports with the Securities and Exchange Commission and the reports must be accessible at the Securities and Exchange Commission Reading Room in Chicago, Illinois.
5. A firm must have filed the annual report section of the 10-K report by March 31, 1980.

The unexpected change in each of the financial ratios is computed as the difference between the expectation of the ratio prior to the annual accounting information release and the realization of the ratio which is the result of the release of the annual data. For the expectations of the 1979 year-end ratios, the market has realized the data contained in the quarterly earnings announcements and quarterly 10-Q reports for the first three quarters. Therefore, the expectations of the yearly accounting data used in this study is a composite of the actual quarterly results for the first three quarters of 1979

and an estimate of the fourth quarter. This estimate of the fourth quarter results for 1979 is a naive model based on the results of the fourth quarter of 1978. The expected year end value for 1979 is the sum of the results for the previous four quarters. Therefore, the unexpected change in each financial ratio is the difference between the expected ratio for year end 1979 and the actual result.

The abnormal returns are computed by controlling for market-wide effects and are based on a four month test period, December 1979 through March 1980. This test period includes the earnings announcement in February and the public release of the audited financial statements by the end of March. A market model is estimated for each firm by regressing the security's monthly returns on the monthly returns of the market for 59 months, January 1975 through November 1979. The estimated parameters are used to predict the monthly returns for the four month test period and the abnormal return is computed as the difference between this predicted return and the actual observed return. The abnormal returns for each of the four months are summed to yield the cumulative abnormal return, CAR. Since the direction (positive or negative) of the impact cannot be specified for the unexpected changes in the liquidity, leverage, and activity dimensions, the analysis is conducted using the absolute values for the fourteen variables of the study. Of the initial sample 42 firms are deleted to normalize the data.

Table 1 presents the lower left triangle of the correlation matrix for the variables used in this analysis.

INSERT TABLE 1

Table 1. Lower Left Triangle of the Correlation Matrix of the Variables of Analysis

Market Reaction	Liquidity				Leverage			Profitability				Activity		
	<u>Y₁</u>	<u>X₁</u>	<u>X₂</u>	<u>X₃</u>	<u>X₄</u>	<u>X₅</u>	<u>X₆</u>	<u>X₇</u>	<u>X₈</u>	<u>X₉</u>	<u>X₁₀</u>	<u>X₁₁</u>	<u>X₁₂</u>	<u>X₁₃</u>
Y ₁	1.000													
X ₁	.113	1.000												
X ₂	.007	.455	1.000											
X ₃	-.078	.032	-.105	1.000										
X ₄	.237	.341	.156	.025	1.000									
X ₅	.083	.377	.464	.101	.477	1.000								
X ₆	.144	.114	.098	.015	.039	.131	1.000							
X ₇	.398	.176	.120	.048	.347	.136	-.050	1.000						
X ₈	.365	.176	.122	-.026	.241	.025	-.068	.769	1.000					
X ₉	.285	.017	.056	.048	.265	.163	.017	.698	.548	1.000				
X ₁₀	.264	.126	.074	.060	.315	.158	.049	.836	.696	.710	1.000			
X ₁₁	.062	.074	.017	.171	.148	.026	-.009	.344	.143	.104	.177	1.000		
X ₁₂	.166	0.73	-.007	.267	.322	.027	.143	.282	.137	.295	.330	.171	1.000	
X ₁₃	.104	0.57	.089	.079	.335	.322	.027	.262	.053	.208	.153	.496	.399	1.000

Appendix C provides the hypothesized model parameter specifications for the matrices of the LISREL model and each estimated parameter is numbered. The overall test of model fit, $\chi^2 = 224.2990$ with 68 degrees of freedom, implies a rather poor fit. However, Bentler and Bonett (1980) point out that the overall chi-square goodness of fit test for a comparison of a hypothesized model structure against a general alternative model structure is insufficient when the sample size or degrees of freedom are large. An alternative is to compare the hypothesized model structure against a null model that specifies independence among all the variables. The null measurement model specifies no common factors by setting all the factor loadings equal to zero. The null structural model sets to zero the links between the market reaction and the unexpected changes in the financial dimensions.

The χ^2 value for the null model is 1147.4164 with 91 degrees of freedom. Let C_1 represent the hypothesized model structure and C_0 the null model. The test of model equivalence can be made by comparing the observed χ^2 values for the two models since the difference in the χ^2 values of the two models is asymptotically distributed as a chi-square variate with degrees of freedom equal to the difference in the number of parameters estimated for each of the two models. Since the χ^2 for C_0 is 1147.4164 (d.f. = 91) and the χ^2 for C_1 is 224.2990 (d.f. = 68) the χ^2 variate for the test of model equivalence is 923.1174 with 23 degrees of freedom. The hypothesis of model equivalence between the null and hypothesized configurations is rejected at the $\alpha = .001$ level.

A measure of the explanatory power of the hypothesized model configuration can be computed (Bentler and Bonett, 1980). This fit index provides a measure of the proportion of the generalized variance in the observed data matrix explained by the hypothesized model structure. The normed fit index is computed as:

$$\Delta_{C_0C_1} = \left[\frac{\chi^2_{C_0}}{N} - \frac{\chi^2_{C_1}}{N} \right] \div \left[\frac{\chi^2_{C_0}}{N} \right] = .804$$

since $\chi^2 = [(-2 \text{ logarithm of the likelihood ratio}) - NF]$ where N is sample size and F is the minimum fit.

The hypothesized model configuration is a significant improvement over the null model since it recreates 80% of the generalized variance for the observed data matrix. This implies that only 20% of the generalized variance is not explained by the hypothesized model configuration.

The Full Information Maximum Likelihood (FIML) estimates and the corresponding t-values for the parameters of the hypothesized model configuration are presented in Table 2.

INSERT TABLE 2

An analysis of the regression coefficients representing the link between unexpected changes in the financial dimensions and the abnormal returns indicates only one significant link. Only the unexpected changes in profitability are linked to the observed abnormal returns at a reasonable level of statistical significance.

Table 2. Parameter Estimates and t-Statistics

Parameter	Estimate	t-Statistic
1 (λ_{11})	.697	8.508
2 (λ_{12})	.654	8.120
3 (λ_{13})	-.003	-.038
4 (λ_{24})	.635	8.629
5 (λ_{25})	.747	9.998
6 (λ_{26})	.150	1.883
7 (λ_{37})	.960	18.206
8 (λ_{38})	.795	13.475
9 (λ_{39})	.740	12.172
10 (λ_{310})	.875	15.611
11 (λ_{411})	.534	6.955
12 (λ_{412})	.458	6.011
13 (λ_{413})	.895	10.555
14 (γ_{11})	-.191	-.812
15 (γ_{12})	.291	1.055
16 (γ_{13})	.380	4.973
17 (γ_{14})	-.112	-.784
18 ($\sigma_{\xi_1 \xi_2}$)	.748	9.167
19 ($\sigma_{\xi_1 \xi_3}$)	.214	2.441
20 ($\sigma_{\xi_2 \xi_3}$)	.314	3.823
21 ($\sigma_{\xi_1 \xi_4}$)	.119	1.235

Table 2 (continued)

Parameter	Estimate	t-Statistic
22 $(\sigma_{\xi_2 y_4})$	.504	5.999
23 $(\sigma_{\xi_3 \xi_4})$	.311	4.190
24 $(\sigma_{\zeta_1}^2)$	.821	9.250
25 $(\sigma_{\delta_1}^2)$	.515	5.611
26 $(\sigma_{\delta_2}^2)$	.572	6.511
27 $(\sigma_{\delta_3}^2)$	1.000	10.124
28 $(\sigma_{\delta_4}^2)$	.597	7.759
29 $(\sigma_{\delta_5}^2)$	.442	5.465
30 $(\sigma_{\delta_6}^2)$	.977	10.049
31 $(\sigma_{\delta_7}^2)$	.079	3.248
32 $(\sigma_{\delta_8}^2)$	.368	8.989
33 $(\sigma_{\delta_9}^2)$	.452	9.361
34 $(\sigma_{\delta_{10}}^2)$	.234	7.603
35 $(\sigma_{\delta_{11}}^2)$	.715	8.587
36 $(\sigma_{\delta_{12}}^2)$	.790	9.252
37 $(\sigma_{\delta_{13}}^2)$	.200	1.687

However, even though the coefficient may not be statistically significant the linkages between the other dimensions and the abnormal returns may be important when the total model configuration is considered. The overall χ^2 values for various model configurations (regarding the γ 's) are provided in Table 3.

INSERT TABLE 3

In all four cases in which only one γ is estimated, the regression coefficient is statistically significant. However, the linkage to profitability is the strongest ($t = 5.768$). A comparison of the full original model (all γ 's estimated) to the restricted model in which only γ_3 is estimated indicates only a marginal improvement when γ_1 , γ_2 , and γ_4 are added. The R^2 is only increased by .022 when the other three coefficients are included in the model. A χ^2 test of equivalence among the model structures fails to reject the null of no difference.

Although the unexpected changes in the liquidity, leverage, and activity dimensions covary with the unexpected changes in profitability these results indicate that the market reaction is driven mainly by the unexpected changes in earnings. It seems that the information content of annual accounting data may be jointly determined but profitability is the strongest factor. Supporting Gonedes (1974) these results imply that the market reaction to the release of annual accounting data is a rather complex process which is not solely driven by earnings. In addition, the results indicate that the study of one of the dimensions without considering the others may lead to misleading implications.

Table 3. Chi-Square Values of Alternative
Model Configurations

<u>Model Specification</u>	<u>T-Values for Estimated Coefficients</u>	<u>χ^2</u>	<u>d.f.</u>
1. $\gamma_2 = \gamma_3 = \gamma_4 = 0$	$\gamma_1 = 2.100$	254.6675	71
2. $\gamma_1 = \gamma_3 = \gamma_4 = 0$	$\gamma_2 = 3.33$	249.4574	71
3. $\gamma_1 = \gamma_2 = \gamma_4 = 0$	$\gamma_3 = 5.768$	225.8411	71
4. $\gamma_1 = \gamma_2 = \gamma_3 = 0$	$\gamma_4 = 2.699$	253.0650	71
Original Model (all γ 's estimated)		224.2990	68

Conclusions

A model linking unexpected changes in accounting variables is hypothesized, estimated, and tested using structural equation modeling techniques. Four financial dimensions are hypothesized and the observable ratios are constrained to load on the dimensions they are expected to measure. The results indicate that the hypothesized model configuration explains 80% of the generalized variance in the variance-covariance matrix of the observed variables.

This approach demonstrates the usefulness of a measurement model to aggregate accounting information into four basic financial dimensions. In studies involving numerous accounting data items, the use of a measurement model is warranted when multicollinearity is expected. Instead of trying to eliminate the collinearity among the accounting variables, a measurement model approach uses the collinearity among the variables to estimate an underlying construct as the source of systematic covariation.

In addition, the results imply that the study of the information content of one of the dimensions other than profitability without modeling the effect of profitability may lead to misleading conclusions.

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Appendix A

LISREL terminology

Types of Variables

η (eta)	Dependent (endogenous) variable: true (i.e., unobserved)
ξ (xi)	Independent (exogenous) variable: true (i.e., unobserved)
y	Indicator of dependent variable (observed)
x	Indicator of independent variable (observed)
ϵ	Measurement error in observed dependent variable
δ	Measurement error in observed independent variable
ζ	Sources of variance in η not included among the ξ 's

Counts

m	Number of true dependent variables
n	Number of true independent variables
p	Number of observed dependent variables
q	Number of observed independent variables

Data-oriented Matrices

\underline{S}	$(p+q \times p+q)$, Variance-covariance matrix among the observed independent and dependent variables (or correlation matrix)
$\underline{\Sigma}$ (sigma)	$(p+q \times p+q)$, Model-generated estimates of variances and covariances among observed independent and dependent variables

Basic Parameter Matrices

$\underline{\Lambda}_y$ (lambda)	$(p \times m)$, Matrix of regression coefficients (λ 's) relating true dependent variables to observed dependent variables
$\underline{\Lambda}_x$ (lambda)	$(q \times n)$, Matrix of regression coefficients (λ 's) relating true independent variables to observed independent variables

<u>B</u> (beta)	(m x m), Matrix of regression coefficients interrelating true dependent variables
<u>Γ</u> (gamma)	(m x n), Matrix of regression coefficients (γ's) relating true independent variables to true dependent variables; indicates direct effect
<u>Φ</u> (phi)	(n x n), Variance-covariance matrix among true independent variables (or correlation matrix)
<u>Ψ</u> (psi)	(m x m), Variance-covariance matrix among zeta variables (or correlation matrix)
<u>Θ_ε</u> (theta)	(p x p), Variance-covariance matrix among epsilon variables (or correlation matrix)
<u>Θ_δ</u> (theta)	(q x q), Variance-covariance matrix among delta variables (or correlation matrix)

Supplementary Parameter Matrices

<u>C</u>	(m x m), Variance-covariance matrix among true dependent variables
<u>D</u>	(m x n), Matrix of regression coefficients for reduced form of structural equations--i.e., coefficients which relate each true dependent variables to true independent variables, giving direct and indirect effects combined

Appendix B

χ^2 test in the analysis of covariance structures (Bentler and Bonett, 1980)

Let M_k be a more restrictive model than M_t . In general, the function $L(\theta)$ is related to the logarithm of the likelihood function of the observations via

$$L^*(\theta) = -n L(\theta)/2 + c$$

where c is independent of θ . (See Joreskog: Psychometrica, 1967, 32, 443-482).

Let $L^*(\theta_k)$ be the maximum of $L^*(\theta)$ under M_k ; let $L^*(\theta_t)$ be the maximum of $L^*(\theta)$ under M_t . Thus

$$L^*(\theta_k) \leq L^*(\theta_t)$$

since the maximum under a space of restricted range cannot exceed the maximum under a space of less restricted range.

Consequently,

$$\log \lambda = L^*(\theta_k) - L^*(\theta_t)$$

is negative, with $0 < \lambda \leq 1$.

To test the null hypothesis of model equivalence ($H_0: \theta_k = \theta_t$), $(-2 \log \lambda)$ is asymptotically distributed as a chi-square variate. The degrees of freedom is the difference in the number of parameters estimated under M_t and M_k . This test is a test of the equality of the parameters under the two models. Since the free parameters in

θ_k are a subset of the free parameters in θ_t , various applications of the test can be constructed.

The null hypothesis associated with model comparisons has an alternative form. The alternative is that the covariance matrices generated by the parameter vectors are equivalent under the M_k and M_t structural models. The significance test is the same as previously described.

Appendix C

Parameter specifications for hypothesized model

	$\underline{\Lambda_x}$			
	ξ_1	ξ_2	ξ_3	ξ_4
x_1	1	0	0	0
x_2	2	0	0	0
x_3	3	0	0	0
x_4	0	4	0	0
x_5	0	5	0	0
x_6	0	6	0	0
x_7	0	0	7	0
x_8	0	0	8	0
x_9	0	0	9	0
x_{10}	0	0	10	0
x_{11}	0	0	0	11
x_{12}	0	0	0	12
x_{13}	0	0	0	13

$\underline{\Gamma}$			
14	15	16	17

$$\begin{array}{c} \Psi \\ \hline [24] \end{array}$$

[illegible]

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